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ABSTRACT

This study examines how self-regulatory interventions affected the biology self-efficacy of a sample of non-science majors enrolled in a Midwestern community college. Portfolio assignments and a survey instrument were used to measure the self-efficacy of college non-majors for performing biology-related tasks. Results show that the vast majority of students are at nominal and functional levels of literacy whereas very few students are at the conceptual and application levels. It was also concluded that males had more significant changes in self-efficacy than did females. (KHR)

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Effects of Self-Regulatory Interventions on the Self-Efficacy of Community College Non-Science Majors

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Objectives of the Study

This study set out to examine how self-regulatory interventions (specifically, goal setting, concept mapping, and reflective writing) affected the biology self-efficacy of a sample of non-science majors enrolled in a mid-western community college. The following questions guided the research design and methodology:

1. How does the use of selected self-regulatory interventions (specifically, goal setting, reflective writing, and concept mapping) affect the biology self-efficacy of non-majors?
2. What demographic factors have the greatest influence on biology self-efficacy?
3. Are changes in biology self-efficacy related to change in level of scientific literacy (as measured by course grades and portfolio assignments)?

Significance

Recent reforms in science education have continued to grow from their beginnings in the late 1980s/early 1990s. *The National Science Education Standards* (NRC, 1996) and *Project 2061* saw the height of their popularity in the 1990s, communicating the need for instruction to increase science literacy by students at all K-12 grade levels. However, students in postsecondary situations were not considered in either of those initiatives. The needs for science literacy at the college level have begun to become more prominent over the last two years. *College Pathways to the Science Education Standards* (NSTA, 2001) has been the first document produced to specifically address extrapolation of the K-12 national science standards to students in the college classroom.

Students in the college science classroom are in need of interventions to promote science literacy just as are students at lower grade levels (NSTA, 2001). The science

teachers who will be teaching science to K-12 students in the future receive the bulk of their science content training in college. In addition, the vast majority of students on an average community college campus are not pursuing careers in a natural science field (i.e. biology, chemistry, physics). These non-majors often receive their only installment of education in science during a required introductory science course. Since the focus of *Project 2061* is to produce scientifically literate students (including adult students), attempting to achieve large amounts of science literacy in one introductory science class seems unrealistic if not impossible. So the question arises: what is known about the Biology self-efficacy of non-majors and how can the science literacy of non-science majors be improved?

Theoretical Background

For more than two centuries, the place of science in the K-12 school curriculum has varied in importance (DeBoer, 1991). In the early years of the United States science was a discipline offered only to the wealthy elite college scholar, who was destined for a prominent position in society. Even then, science was very new to the West, and most information taught in a science class was ill-defined and sporadic in the curriculum.

With the scientific revolution of the late 1800s/early 1900s, many of the normal schools in the American educational system began to include science in their daily curriculum, providing students with rudimentary concepts in natural sciences like biology, chemistry, physics, and astronomy. While science had a more prominent place in the curriculum, the main focus of education remained to be reading, writing, and mathematics, all coming from a religious base.

As the 1900s progressed, science came to hold greater importance in the classroom. By the 1940s and 1950s, the United States government pushed politically for the training of as many scientists as possible to aid the development of nuclear weapons and new technologies for World War II, and to further the Space Race in the late 1950s/early 1960s. It was not until the late 1980s (after the end of the Cold War) that educational needs began to change in science. There was less political influence and more from educators and those in the educational community. Reforms began to emerge which focused on how students learned information and processes in science. Content was not the main emphasis as before, but more an understanding of how science is done which could aid someone in making decisions in their daily life. As a result, a new term to describe this goal of this change in educational paradigm was introduced and quickly became the fashionable referent in science education: scientific literacy.

With the hype surrounding scientific literacy since then, there has not been an accepted definition for scientific literacy since it was introduced (DeBoer, 2000). However, DeBoer commented that there is little argument that scientific literacy centers on the development of specific knowledge of scientific concepts and skills which enable one to understand and participate in the process of science. Those individuals possessing scientific literacy should be able to make decisions regarding matters of scientific origin or research, have higher level thinking skills, be able to solve problems in a scientific manner, and be generally knowledgeable about basic scientific facts and theories. The goal is to have students come away with working and practical knowledge they can use to solve problems, make informed choices, and take an active role in scientific matters they might encounter on a daily basis.

In order to address pedagogical concerns with how best to achieve the goal of scientific literacy, the American Association for the Advancement of Science (AAAS) developed the *Project 2061* initiative. This project had a goal of creating a scientifically literate population by the year 2061, the year Comet Halley next returns to view on the Earth. To begin to address this goal, in 1989 AAAS published *Science for All Americans*, the first document to describe the components of scientific literacy in depth. This was followed in 1993 by *Benchmarks for Science Literacy*, which took the descriptions from *Science for All Americans* and set out specific benchmarks, or goals, for students in different grade levels for achieving literacy.

It was not until 1996 that specific grade-by-grade standards for science education were offered. *The National Science Education Standards* (National Research Council, 1996) was the first document specifically focused on science education in the K-12 classroom, schools, system-wide settings, and in teacher training and professional development. Since its publication, this book has become the guide for the development and reform of science education programs at the K-12 level.

Since the start of the current millennium, reforms in science education have continued to grow. *The National Science Education Standards* and *Project 2061* saw the height of their popularity in the 1990s, communicating the need for increased science literacy by students at all K-12 grade levels. However, students in postsecondary situations were not discussed in either of those initiatives. The needs for science literacy at the college level have begun to become more prominent over the last two years. *College Pathways to the Science Education Standards* (NSTA, 2001) was the first

document produced to specifically address extrapolation of the K-12 national science standards to students in the college classroom.

Students in the college science classroom are just as in need of experiences that promote science literacy as are students at lower grade levels (NSTA, 2001). The science teachers who will be teaching science to K-12 students in the future receive the bulk of their science training in college. In addition, the vast majority of students on an average college campus are not pursuing careers in a natural science field (i.e. biology, chemistry, physics). These non-majors often receive their only exposure to science during a required introductory science course. Since the focus of *Project 2061* is to produce scientifically literate students (including adult students), attempting to achieve large amounts of science literacy in one introductory science class seems unrealistic if not impossible. So the question arises: how can the science literacy of non-science majors be improved?

Pathways to the Science Education Standards offered a wealth of information regarding possible approaches that can be taken in the college science classroom to promote scientific literacy development. Specifically, approaches to the improvement of process skills, higher-level thinking, making real-world connections, and the use of alternative forms of assessment, were addressed in vignettes composed by researchers and practitioners who have implemented specific strategies in their own classroom situations. While these discussions are not step-wise procedures for achieving science literacy, they offered suggestions based on experience (and some on research findings) for promoting an atmosphere conducive to literacy development. In addition, the

vignettes were discipline-specific, so readers could see how approaches in chemistry may be different than those taken in a biology classroom, or in physics, geology, etc.

It is important to note that *Pathways to the Science Education Standards* is the first book emerging from recent reforms and standards to stress the importance of developing science literacy at the college level, specifically for non-science majors. This is a new and emerging topic of research in science education. Studies done in the past dealing with non-majors do not come from a reform or standards-based philosophy for improving science literacy. The current trends in science education reform, although having begun in the late 1980s, are continuing to grow and develop. The focus on college-level standards-based science education is one of these trends. As such, the door is now open for a great deal of empirical research in this area to investigate the most effective ways to improve science literacy for college students, especially non-science majors.

Learning by non-majors in science, or by students in any discipline, is dependent on student motivation and skill for mastering a given situation or task. Students develop learning strategies based on their own past experiences and what they are taught by knowledgeable others (peers, teachers, parents). Individual control over one's personal learning experience and skills falls under the realm of self-regulation.

Schunk and Ertmer (2000, p.631) stated: "Self-regulation (or self-regulated learning) refers to self-generated thoughts, feelings, and actions, that are planned and systematically adapted as needed to affect one's learning and motivation." They listed a number of processes which are important to self-regulation. They include:

- setting goals for learning
- attending to, and concentrating on, instruction
- using effective strategies to code and rehearse information to be learned
- establishing a productive work environment
- using resources effectively
- monitoring performance
- managing time effectively
- seeking assistance when needed
- holding positive beliefs about one's capabilities, the value of learning, the factors influencing learning, and the anticipated outcomes of actions
- experiencing pride and satisfaction with one's efforts

Any one or any combination of these would be classified as a form of self-regulation. Ultimately, self-regulation focuses on the student, and how best to encourage activities or strategies that will be most effective in developing long-term habits which will aid their learning.

As Schunk and Ertmer (2000) discussed further, self-regulation is closely tied to self-efficacy. The use of self-regulatory activities, such as those listed above, often results in direct concurrent changes in self-efficacy for the given learning task students are being asked to perform. It would follow then, that by promoting the use of specific self-regulatory activities in a science classroom, students who respond positively to these interventions should also have an increase in self-efficacy. Thinking in terms of non-majors, promoting self-regulatory learning strategies (and thus increasing self-efficacy) could have potential positive effects on the development of skills and knowledge leading to increased levels of science literacy.

Given the problem of how best address improvement of science literacy in non-science majors (specifically those in biology for this study), the following questions for this research study were proposed:

1. How does the use of selected self-regulatory interventions (specifically, goal setting, reflective writing, and concept mapping) affect the biology self-efficacy of non-majors?

2. What demographic factors have the greatest influence on biology self-efficacy?

3. Are changes in biology self-efficacy related to change in level of scientific literacy (as measured by course grades and portfolio assignments)?

Baldwin, et al. (1999) developed a survey instrument to measure self-efficacy changes of non-majors to perform tasks specific to a biology classroom. What made their study unique was that the survey items consisted of tasks specific to increasing biological literacy as well. Therefore, students who had increases in self-efficacy for the tasks the survey measured also had increases in biological literacy. Baldwin, et al., confirmed the literacy findings through the use of a separate assessment, the NABT High School Biology Exam.

Not to be confused with self-regulation, self-efficacy is a construct first put forth by Bandura (1977). Bandura stated that self-efficacy dealt with one's beliefs regarding the completion of a given task. Self-efficacy could come from four possible areas: enactive mastery experiences, verbal persuasion, vicarious learning, or affective states.

Enactive mastery experiences deal specifically with an individual being able to successful complete an assigned task or learning experience. By gaining positive experiences, an individual should feel more efficacious to take on or complete future tasks of a similar nature.

Verbal persuasion involves written or auditory feedback by a knowledgeable other, such as a teacher. Positive support may instill more positive efficacious beliefs regarding a current task, and can lead to higher efficacy for a similar future situation.

Vicarious learning is centered on observation of peer. Here, the person with low efficacy watches a peer with similar characteristics successfully complete a task. This may lead to a feeling of "if he/she can do it, I can do it." As such, the individual may then be more efficacious and attempt to complete the task on his/her own.

Finally, influences of affective states may be a factor. By affective states, Bandura referred to physiological conditions which may influence an individual's self-efficacy. For example, if a student gets little sleep the night before an exam, the physical fatigue and fogginess of mind could lead to low efficacy for performing well on the exam. Alternatively, a student who is well-rested, prepared, and feels confident about the material may have very high efficacy for completing the exam successfully. Therefore, physical states, mood, and emotions, are all potential players in affecting one's self-efficacy in any given situation.

While Bandura's four original components of self-efficacy (1977) have stood the test of time, a number of researchers (i.e. Pajares, 1996; Schunk, 1996) have expanded Bandura's work to focus more on academic and learning-centered settings. Schunk & Pajares (in press) postulated additional sources of self-efficacy, such as: familial influences, peer networks, schooling influences, transitional influences, and gender influences. Schunk (1996) made an important distinction between the types of tasks involved in Bandura's early work and learning tasks being asked of students in a classroom. In the classroom, other factors come into play, such as knowledge acquisition, skills, strategies, and prior experience in similar situations. As a result, the self-efficacy beliefs of learners include more mosaic qualities that differ on an individual basis. While still focusing on Bandura's four self-efficacy components, the study of self-

efficacy for learning brings more to the table as each individual assess their own efficacy beliefs for a given learning task.

Self-efficacy, then, can be a major factor in any learning situation. Given the case of non-science majors, it would seem that it could play a critical role. The vast majority of non-science majors have a limited science background and therefore few successful science experiences on which to base their self-efficacy beliefs. Their fellow students in class (peers) are in the same situation, so vicarious effects going in to a course would seem to be limited. Verbal feedback and physiological states are also difficult to assess given the diverse backgrounds of students in a college environment. Therefore, it is very likely that self-efficacy for learning science will be low to marginal in a new class of non-majors.

In summary, the problem of how best to increase scientific literacy in non-majors is both relevant and current. Research into this area is still new and emergent, providing science educators with multiple modes to research this issue. As discussed above, learning interventions dealing with self-regulatory activities designed to promote increased biology-self-efficacy are proposed for this study. It is expected that by teaching students more effective self-regulatory learning strategies, their self-efficacy to perform tasks utilizing those strategies will increase. As such, when the tasks students are being asked to perform directly influence their level of scientific literacy, an increase in self-efficacy for these specific tasks should lead to increased academic achievement and scientific literacy overall.

Research Design and Procedure

Participants in this study were enrolled in an introductory biology course at a community college in the mid-western United States. This course was an introduction to the biological sciences for the non-major student. Topics included in the course were: cell structure and function, bioenergetics, DNA structure and function, cell reproduction, biodiversity, ecology, and evolution. The course covered a 10-week period of instruction. Students registered in the two sections of the course taught by the researcher were asked to participate in the study. Both sections received self-regulatory interventions.

These groups were given specific activities (See Appendix A) to complete as part of their course requirements which focused primarily on self-regulatory learning strategies. These assignments included: goal setting, reflective writing, and concept mapping. The self-regulatory assignments were housed in a portfolio for ease of collection and grading. A rubric (given with the assignments) was used to score each activity.

A survey instrument (see Appendix B), adapted from Baldwin, et al. (1999), was used in this study to measure self-efficacy of college non-majors for performing biology-related tasks. The items on the survey cluster into three domains: methods of biology, generalization to other biology/science courses and analyzing data, and application of biological concepts and skills (p.404). These items represent outcomes for biologically literate students as described in other literature (Bybee, 1997). As such, the survey provides information regarding student beliefs about their ability to complete tasks that would result in them becoming more biologically literate.

For this study, the survey was given two times during the course. It was used a pre-survey during the first week of the course. The survey was given to the same students during the final class period of the course (day of the final exam) as a post-survey. Analysis of survey data was done using SPSS. Data was analyzed to identify significant differences between pre-survey and post-survey scores.

Each student's portfolio assignments were analyzed using a scoring rubric (see Appendix C) to assess levels of biological literacy exhibited in the activities. Based on Bybee (1997), each assignment was assessed for biological literacy on three possible levels: nominal biological literacy, functional biological literacy, and conceptual biological literacy. Nominal literacy was scored on the following criteria:

· minimal use of biological terms presented in class
· has performance goals relating to passing grades
· final course grade below 75%
· follows directions of course assignments
· completes some course assignments

Functional literacy was scored using these criteria:

· accurate use of biological terms presented in class
· has learning goals to learn some biological concepts
· final course grade of at least a C (75%)
· locates and uses information outside of class that is relevant to course assignments
· completes all course assignments

Conceptual literacy was scored on the following set of items:

· demonstrates understanding of relationships among biological concepts presented in class
· demonstrates application of many concepts
· has goals to use course information to inform personal choices (i.e. necessary for career path, to make personal decisions, to be an informed citizen, etc.)
· final course grade higher than 75%
· communicates understanding and correctly uses concepts in reflective writings
· demonstrates understanding of the role of scientific procedures/skills in assignments
· asks questions in our outside of class about topics of interest

Data from these biological literacy rubrics were combined with qualitative components from students' assignments and survey data to provide triangulation of methods for specific cases.

Data and Results

Preliminary results of all data collected are described in relation to their specificity for each of the three initial research questions.

I. *How does the use of selected self-regulatory interventions (specifically, goal setting, reflective writing, and concept mapping) affect the biology self-efficacy of non-majors?*

Examining the data using paired t tests demonstrated significant differences between pre and post survey scores on a number of levels. As stated previously, the individual items of the survey instrument used have been shown by others (Baldwin, et al., 1999) to factor into the following three categories:

- methods of biology
- generalization to other biology/science courses and analyzing data
- application of biological concepts and skills

Table 1 demonstrates the number of significant differences seen on the 23 item survey. Overall, 14 of the 23 possible items showed significant differences between pre and post measures. When examined based on the 3 categories of items listed above, the following trends were observed: methods of biology, 7 items; generalization to other biology/science courses and analyzing data, 6 items; and application of biological concepts and skills, 1 item.

Table 1.
Numbers of Overall Significant Differences Seen in Comparing Pre/Post Survey Items

Category	Number of Significant Differences
Overall (23 possible items)	14 (61%)
Methods of Biology (8 possible items)	7 (88%)
Generalization to Other Biology/Science Courses and Analyzing Data (9 possible items)	6 (67%)
Application of Biological Concepts and Skills (6 possible items)	1 (17%)

These overall trends demonstrate noteworthy events. First, of the 23 possible items of the survey, a large majority (61%) had significant differences. This indicates that the majority of students had a significant change in their biology self-efficacy during the course. Broken down further, the largest percentages of significant differences were seen in items relating to methods of biology (88%) and generalization to other biology/science courses and analyzing data (67%). Application of biological concepts and skills showed only a marginal difference in 17% of possible items being significant.

In examining individual cases, student responded to the portfolio assignments and commented on the overall effectiveness of goal setting, reflective writing, and concept mapping. Most students indicated in their portfolio responses that they were in favor of one the three strategies in helping them learn the material but offered no explanation or elaboration as to why their chosen strategy was beneficial. In addition, while most students followed the directions of the assignments, the depth and quality of their work was on a superficial level. Two students who received an A in the course, Stacey and

Malinda, were in favor of the concept mapping activities. When asked which type of assignment was most useful, Stacey remarked:

"Concept mapping, because the others did nothing to help my understanding of the material in this course."

Malinda had similar comments:

"Concept mapping, because I wrote it out step by step and could see it in my own style. That helped a lot."

Having such succinct and sparse feedback from the majority of students makes the effectiveness of these interventions difficult to ascertain, at least in a subjective qualitative manner. Few students, like Stacey and Malinda, demonstrated a great deal of effort on their assignments. As such, the portfolio data for all students would appear to be much more telling on a case by case basis, than to attempt to generalize results from the larger group.

(See Appendix D for examples of Stacey's and Malinda's concept maps. While both show initial and simplistic efforts at the mapping activities, their comments do indicate that the organization of the material did help them understand the information.)

II. *What demographic factors have the greatest influence on biology self-efficacy?*

During administration of the survey instrument, the following demographics were collected: gender, ethnicity, grade point average, marital status, numbers of previous science courses taken, and major area of study. Upon t test analysis, no noteworthy significant differences were noted in any of the demographics except for gender and ethnicity. These data are presented below in Table 2.

Table 2.
Number of Significant Differences Seen in Gender and Ethnic Groups

Category	Males	Females	Caucasian	Asian/South Pacific	African American
Overall (23 possible items)	14 (61%)	4 (17%)	11 (48%)	0	0
Methods of Biology (8 possible items)	8 (100%)	2 (25%)	6 (75%)	0	0
Generalization to other Biology/Science Courses and Analyzing Data (9 possible items)	5 (56%)	2 (22%)	5 (56%)	0	0
Application of Biological Concepts and Skills (6 possible items)	1 (17%)	0	0	0	0

In all groupings, males had more significant differences than females. However, it is interesting to note that males declined much more quickly in their significant self-efficacy differences between categories than did females. It is interesting to note that both groups were close to zero in the final category of biological application of concepts and skills. This corresponds to the overall results seen in Table 1, of very low numbers in this category.

In terms of ethnic background, Caucasian students were the only group to exhibit significant self-efficacy differences, regardless of survey category. Interestingly, none of the groups demonstrated any significant changes in the final survey category, a trend seen elsewhere in the data.

III. *Are changes in biology self-efficacy related to change in level of scientific literacy (as measured by course grades and portfolio assignments)?*

The students receiving passing course grades (A, B, C, D) were analyzed in regards to their change in self-efficacy, as done in the data described above. Table 3 lists the results when grouped by course grade.

Table 3.
Final Course Grades in Relation to Number of Significant Differences in Biology Self-Efficacy

Category	A	B	C	D
Overall (23 items possible)	0	10 (43%)	0	0
Methods of Biology (8 items possible)	0	5 (63%)	0	0
Generalization to other Biology/Science Courses and Analyzing Data (9 items possible)	0	4 (44%)	0	0
Application of Biological Concepts and Skills (6 items possible)	0	1 (17%)	0	0

In all cases, only students who received a B in the course exhibited significant differences in their self-efficacy scores. No other course grade grouping had any significant changes. Also, it is interesting to note that again the first two categories of questions of the survey had the most significant differences, while the third category (application of biological concepts and skills) had the fewest. Since course grades were used a proxy measure of scientific literacy, this data demonstrates that students who received a B in the course had the most significant differences in their level of scientific literacy during the course.

One of the more telling pieces of data used to answer this research question comes from the portfolio assignments. As was described earlier, each set of portfolio

assignments was scored used a rubric constructed to assess biological literacy on three levels: nominal, functional, and conceptual (based on Bybee, 1997). Each type of literacy was defined by a set of criteria specific to the portfolio and course tasks students were asked to complete. Each criterion component was given a subjective rating of +, ++, or +++, to assess the student's level of effectiveness. An interesting trend emerged. All students, regardless of demographic factor or final course grade, tended to have their levels of biological literacy divided between nominal and functional levels. Only a few students—all of which received high A grades—had a representative literacy component at the conceptual level.

Returning to our two previous cases of Stacey and Malinda, Stacey had strong (++ or higher) scores on nearly all components at the nominal and functional levels. She had only two scorings at all at the conceptual literacy level. Malinda was very similar. She strong scores in nominal and functional categories, but also demonstrated a number of lower level scores (mainly all +) in conceptual literacy. For comparison, one student who received a B in the course, Lisa, had all low level scores (+) in just nominal and functional levels.

Since the portfolio assignments were aggregated and scored as a group, the results indicated on the rubrics tell the story for each student's literacy during the course collectively. The results indicate that most all students left the course with, at best, a functional level of biological literacy.

Discussion and Implications

The preliminary data discussed here provide a number of noteworthy and interesting trends to be explored further. First, a number of significant differences in self-efficacy do exist between pre and post survey measures. This lays the groundwork for numerous areas of further study. In all analyses, two categories of questions on the survey (methods of biology; generalization to other biology/science courses and analyzing data) had many more differences in pre/post measures than did the third category of application of biological skills and concepts. For this particular group of non-majors, it would seem that the types of activities covered in two of the categories of survey questions are those which students had distinctive changes in self-efficacy towards. Comparing these data with those of the biology literacy scores on the self-regulatory interventions provides an interesting corollary which shows the vast majority of students at nominal and functional levels of literacy, with very few at the conceptual/application level. These two types of data would seem to support each other in those conclusions.

A second trend in the data worthy of note deals with demographics. Males continuously had more significant changes in self-efficacy than did females. This could mean that males may have demonstrated more efficacious behaviors as a result of the intervention and females did not, or that females were consistently high or low in their efficacy, result in less change over time. A more in-depth exploration into the gender-based self-efficacy differences seen here would definitely be warranted.

Third, the fact that all students scored highly in the levels of nominal and functional literacy with very few at the conceptual level begs further investigation. It is

not surprising that these non-majors students have beginning to somewhat moderate levels of biological literacy. Most did not have an extensive science background and were only taking the course as a program requirement in another field of study. As such, it would be expected that their literacy levels would be novice. While changes in self-efficacy are very evident, it is more difficult to ascertain how much biological literacy levels changed over time, since students scored relatively low across the board. This may be the result of the effectiveness of the types of interventions used, or the short instructional time of the course (10 weeks). Perhaps a longer time of instruction with the focus on only one type of intervention would be more telling. Also, it would be interesting to follow students taking the entire introductory biology sequence to ascertain their levels of biological literacy in each course, as well as at the end of the sequence.

Since much of this data is preliminary in nature, overall conclusions and generalized implications are not warranted at this point in time. However, the researcher is currently in the process of replicating the study with a second group of non-majors taking the same course. Early results indicate some similarities to the data discussed here in terms of biological literacy scoring, but show less change in self-efficacy over time. As such, in the final analysis to come it may only be prudent to generalize results and conclusions to these particular groups of non-majors or to contextual situations that are very similar in nature. With few studies available on self-efficacy with non-science majors, it will be some time to come before a broad base of literature in this area is developed.

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Appendix A:

Self-Regulatory Interventions

These assignments were housed in a portfolio and one assignment was given during each week of the course.

BIO 111: Portfolio Assignment #1

NAME :

On a separate sheet, write a 1-2 page personal reflection that addresses the following points:

1. How do you feel about your abilities to be successful in this class? What is influencing those feelings the most?
2. What kind of science background do you have?
3. Why are you taking this course (as opposed to other science courses at CSCC)?
4. What learning and performance goals do you have for yourself in this course? Which goals are more important to you?
5. Are there specific topics you would like to see discussed in class?

BIO 111: Portfolio Assignment #2

NAME:

Find a short (1-2 page) current science magazine article that deals with cells or cellular biology. Make a copy of it and attach it to this sheet.

1. How does it relate to what we have covered in class this week regarding cells?
2. What parts of the article did you not understand?
3. Do you feel you would be able to use the knowledge you have on cells to search for information on those difficult areas?
4. What kind of "real world" connection can you see for the information we covered this week? Does this help to make the lecture material more real to you?

BIO 111: Portfolio Assignment #3

NAME:

Make a concept map for the events occurring in photosynthesis. Examples of concept maps can be seen at: http://www.inspiration.com (A free download of concept-mapping software is also available for a 30-day trial should you desire.)

Compare the map you made with those of others in class. Share ideas and make refinements.

1. Have you ever used a concept map as a learning strategy to help organize ideas?
2. How do you feel about using a new learning strategy in this situation?
3. Did you find yourself making lots of changes or starting over? Why or why not?
4. After you finished the concept map, how did you feel about your ability to understand the concepts included in photosynthesis?
5. How do you feel about your ability to construct and use a concept map for another new topic covered in class?

BIO 111: Portfolio Assignment #4

NAME:

This week we will again be using the concept mapping idea for cellular respiration. Your task is to make a concept map for the events occurring in the 3 areas of cellular respiration.

1. Having done a concept map last week, how do you feel about your ability to construct one this week?
2. Did you make as many changes or additions as you did to the one last week?
3. Now that you have completed two mapping exercises, how do you feel about the use of concept mapping as a tool for studying and organizing information?
4. Do you feel you understand these cellular processes better as a resulting of making the maps? Why or why not?
5. Do you think it will be useful for you to use this learning strategy during the rest of the quarter?

BIO 111: Portfolio Assignment #5

NAME:

This week's assignment is a mid-course evaluation. Write a 1-2 page personal reflection including the following points:

1. How do you feel you are doing in class so far?
2. Go back and read the goals you listed in Assignment #1. Are you meeting your goals? If not, what could you change to facilitate that? Are you meeting more of your performance goals, or more of your learning goals?
3. How do you feel about your abilities to be successful in this class compared how you felt at the beginning of the quarter? If you are feeling less able, what could you do to change those feelings?
4. In terms of teaching style and classroom activities, are your needs being met? If not, what realistic changes could be made to assist that?

BIO 111: Portfolio Assignment #6

NAME:

Pick a genetic trait (such as eye color, hair color, etc.) and develop as much of a family tree for that trait as you can.

1. What are phenotypes of the individuals listed?
2. Can you guess as to what the genotypes of those individuals might be?
3. Is the trait you followed mainly a dominant or a recessive one? Why do you think so?
4. Do you feel you could pick another familial trait and create a family tree for that one as well?
5. Do you feel that this assignment helps you connect some of the genetics concepts we have discussed to a more realistic and familiar setting?
6. Compared to the concept maps you have done, is this similar? Why do you think so?

BIO 111: Portfolio Assignment #7

NAME:

Write a 1 page reflection on the basic ideas of the theory of evolution we have discussed in class.

1. Are we as humans evolving? Why or why not?
2. Pick a physical trait specific to humans and discuss how you think that adaptation may have evolved.
3. How could you use a concept map to help you understand the ideas of evolution better? Create a simple one to help you organize some of the major themes here.

BIO 111: Portfolio Assignment #8

NAME:

Write a 1-2 page personal reflection on our trip to Franklin Park Conservatory this week.

1. What new things did you experience there?
2. What kinds of biodiversity did you see?
3. Do you feel you have a better understanding of plants and biomes as a result of this trip? How do you feel about your ability to describe basic differences between biomes and resulting plant characteristics?
4. As a result of our trip, do you feel more knowledgeable about plant life you might find in our Ohio environment? Why or why not?

BIO 111: Portfolio Assignment #9

NAME:

Create a concept map for the 5 Kingdoms of living things we have been studying.

1. As you approach this final mapping exercise, how do you feel about your abilities to organize such a large amount of information?
2. How has this activity helped you organize and make sense of the different Kingdoms and organisms we have studied?
3. What other ways (besides concept mapping) could you organize this information in a manner that would help you learn it? Are there other learning strategies that would help you make sense of this information better? What are they?
4. Has concept mapping been a useful learning tool for you use this quarter? Why or why not?

BIO 111: Portfolio Assignment #10

NAME:

This final activity has 2 parts.

First, write a 1-2 page personal reflection on our trip to the Columbus Zoo.

1. What are some new things you learned?
2. What kind of interactions did you have with the animals? Which were your favorite and why?
3. What kinds of biodiversity did you see here (plant and animal)? What kinds of habitats?
4. How did this trip help you apply the animal classification information we learned about in class?

Second, write a 1-2 page final course evaluation.

1. Begin by looking back at the goals you listed in Assignment #1 and also looking at your progress in Assignment #5. Were you able to meet your goals for this class? If not, why not?
2. How do you feel now about your abilities to be successful in a biology class of this type? What aided those feelings? What helped you learn the most?
3. How confident are you that you would be able to succeed in another biology course?
4. What aided your learning most in this class? What hindered it most?
5. What final recommendations would you make in terms of teaching, learning, and study skills? Other comments?

Appendix B:

Self-Efficacy Instrument

BIO 111 Survey

This survey contains 23 statements about your confidence performing tasks related to biology. For each question, think about how confident you would be in carrying out a given task. There are no right or wrong answers. These are just your own thoughts and feelings about these topics.

In order to answer each question, write the number of your response in the blank provided next to the question. The numbers represent the following:

5 = If you are TOTALLY CONFIDENT that you can do the task.

4 = If you are VERY CONFIDENT that you can do the task.

3 = If you are FAIRLY CONFIDENT that you can do the task.

2 = If you are ONLY A LITTLE CONFIDENT that you can do the task.

1 = If you are NOT AT ALL CONFIDENT that you can do the task.

Practice Item:
"How confident are you that you could give a presentation about birds in northern Arizona?"
Suppose that you were "fairly confident" that you could give a presentation about birds in northern Arizona. You would write the number "3" in the blank next to the question.

Thank you for your participation!

____ 1. How confident are you that after reading an article about a biology experiment, you could write a summary of its main points?

____ 2. How confident are you that you could critique a laboratory report written by another student?

____ 3. How confident are you that you could write an introduction to a lab report?

____ 4. How confident are you that after reading an article about a biology experiment, you could explain its main ideas to another person?

____ 5. How confident are you that you could read the procedures for an experiment and feel sure about conducting the experiment on your own?

____ 6. How confident are you that you could write the methods section of a lab report (i.e. describe the experimental procedures)?

____ 7. How confident are you that after watching a television documentary dealing with some aspect of biology, you could write a summary of its main points?

____ 8. How confident are you that you will be successful in this biology course?

____ 9. How confident are you that you could write up the results of a lab report?

____ 10. How confident are you that after watching a television documentary dealing with some aspect of biology, you could explain its main ideas to another person?

____ 11. How confident are you that you will be successful in another biology course?

____ 12. How confident are you that you could write the conclusion of a lab report?

5 = If you are TOTALLY CONFIDENT that you can do the task.

4 = If you are VERY CONFIDENT that you can do the task.

3 = If you are FAIRLY CONFIDENT that you can do the task.

2 = If you are ONLY A LITTLE CONFIDENT that you can do the task.

1 = If you are NOT AT ALL CONFIDENT that you can do the task.

____ 13. How confident are you that after listening to a public lecture regarding some biology topic, you could write a summary of its main points?

____ 14. How confident are you that you would be successful in an ecology course?

In order to answer each question, write the number of your response in the blank provided next to the question. The numbers represent the following:

____ 15. How confident are you that you could analyze a set of data (i.e. look at the relationships between variables)?

____ 16. How confident are you that after listening to a public lecture regarding some biology topic, you could explain its main ideas to another person?

____ 17. How confident are you that you would be successful in a human physiology course?

____ 18. How confident are you that you could tutor another student on how to write a lab report?

____ 19. How confident are you that you could critique an experiment described in a biology textbook (i.e. list the strengths and weaknesses)?

____ 20. How confident are you that you could tutor another student for this biology course?

____ 21. How confident are you that you could ask a meaningful question that could be answered experimentally?

____ 22. How confident are you that you could explain something that you learned in this biology course to another person?

____ 23. How confident are you that you could use a scientific approach to solve a problem at home?

CONTINUE TO THE NEXT PAGE TO FINISH THE SURVEY...

Please answer each of the following questions:

1. Gender:
   - Male
   - Female

2. Ethnicity:
   - White
   - Hispanic
   - Native American
   - Asian/South Pacific
   - African American
   - Other (write in): _____

3. Age:
   - 18-21
   - 21-25
   - 25-30
   - 30-40
   - 40-50
   - over 50

4. Marital Status:
   - single
   - married
   - divorced
   - widowed

5. Current Grade Point Average:

6. Number of previous college biology courses taken:

7. Major:

Appendix C:

Scoring Rubric to Assess Biological Literacy in Portfolio Assignments

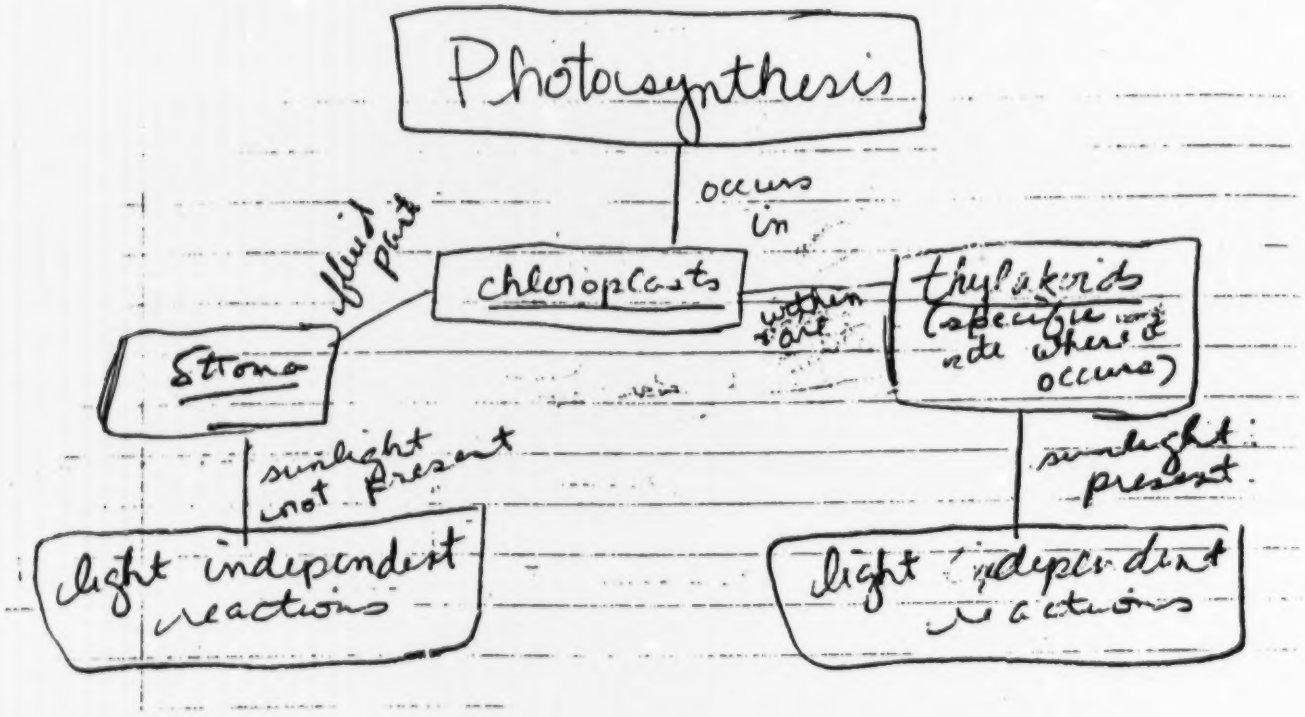
Scoring Rubric to Assess Biological Literacy in BIO 111 Portfolio Assignments

Type of Biological Literacy ↓ Data Sources →	*Missing Data*	*Concept Maps*	*Reflective Writings*	*Goal Setting*	*Article Summary*	*Family Tree*
Nominal Biological Literacy • Minimal use of biological terms presented in class. • Has performance goals relating to passing grades. • Final course grade below 75%. • Follows directions of course assignments. • Completes some course assignments.						
Functional Biological Literacy • Accurate use of biological terms presented in class. • Has learning goals to learn some biological concepts. • Final course grade at least a C (75%). • Locates and uses information outside of class that is relevant to course assignments. • Completes all course assignments.						
Conceptual Biological Literacy • Demonstrates understanding of relationships among biological concepts presented in class. • Demonstrates application of many concepts. • Has goals to use course information to inform personal choices (i.e., necessary for career path, to make personal decisions, to be an informed citizen, etc.). • Final course grade higher than 75%. • Communicates understanding and correctly uses concepts in reflective writings. • Demonstrates understanding the role of scientific procedures/skills in the assignments. • Asks questions in or outside of class about topics of interest.						

Appendix D:

Example Concept Maps from Stacey and Malinda

Stacey's Initial Concept Maps (Photosynthesis):



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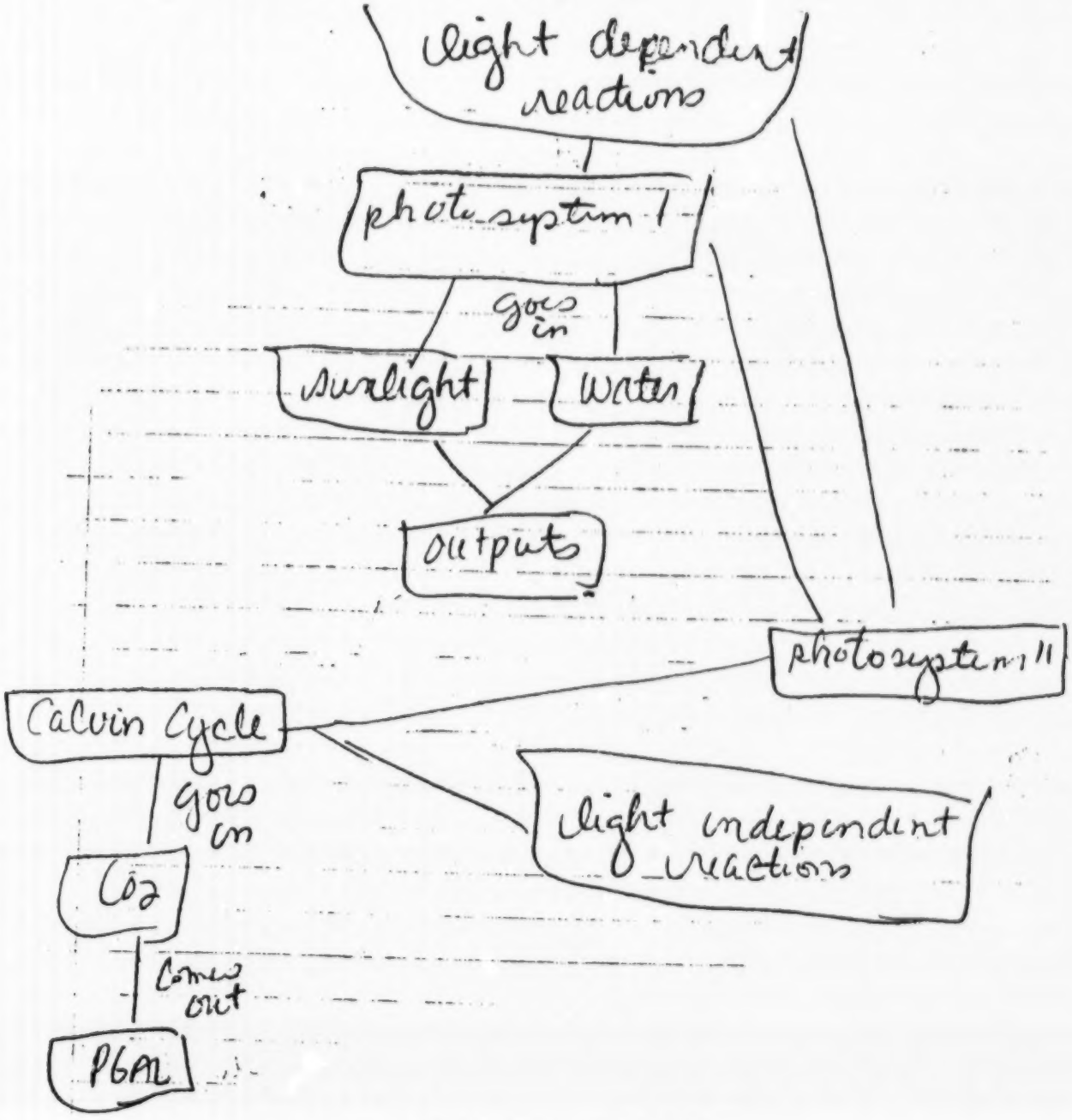
Stacey's Maps Continued:



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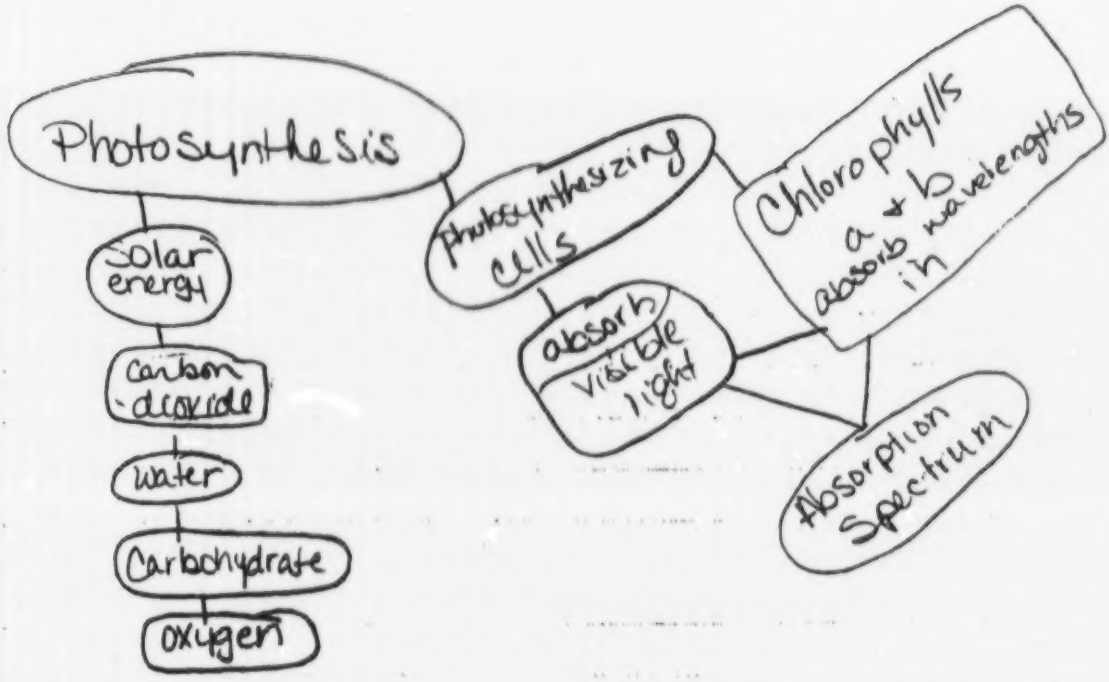
Malinda's Initial Concept Map (Photosynthesis):



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